

**Flash floods, sediment transport and debris flow in steep mountain catchments**  
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**Abstract**

Mountain flash floods are caused by cloudburst or stationary rain cells, heavy rainfalls together with rapid snow melt, glacial lake outburst, failure of dams built up by landslides, rock falls or debris flows as well as by overspill or failure of artificial reservoir dams. The characteristics of mountain flash floods are: sudden rise and rapid decline of discharge and high flow velocities combined with large sediment transport.

Impacts of such flash floods are undercutting of hydraulic structures, bank failure collapse, bank erosion, channel displacement, clogging of bridges, scour, static and dynamic inundation as well as sediment deposits.

The comprehensive flash flood management in Switzerland is based on risk analysis, risk assessment and risk management. In the Federal law on Flood Control the comprehensive analysis, assessment and management of risk, the differentiation approach for protection measures, the adequate planning of measures and the limitation of the remaining risk (emergency planning) is fixed.

The presentation focuses on:

**1) Flood protection principles used in Switzerland**

In Switzerland main flood protection principles are:

- Comprehensive analysis and documentation of the flood hazard is a must.
- Areas and objects of high value require a greater degree of protection than those of lower value.
- Flood peaks should be dampened by retention measures.
- The appropriate maintenance of the river must be guaranteed.
- Flood safety should be provided with minimum impact on natural habitats.

**2) Role of hydrology in supporting mountain flash flood management**

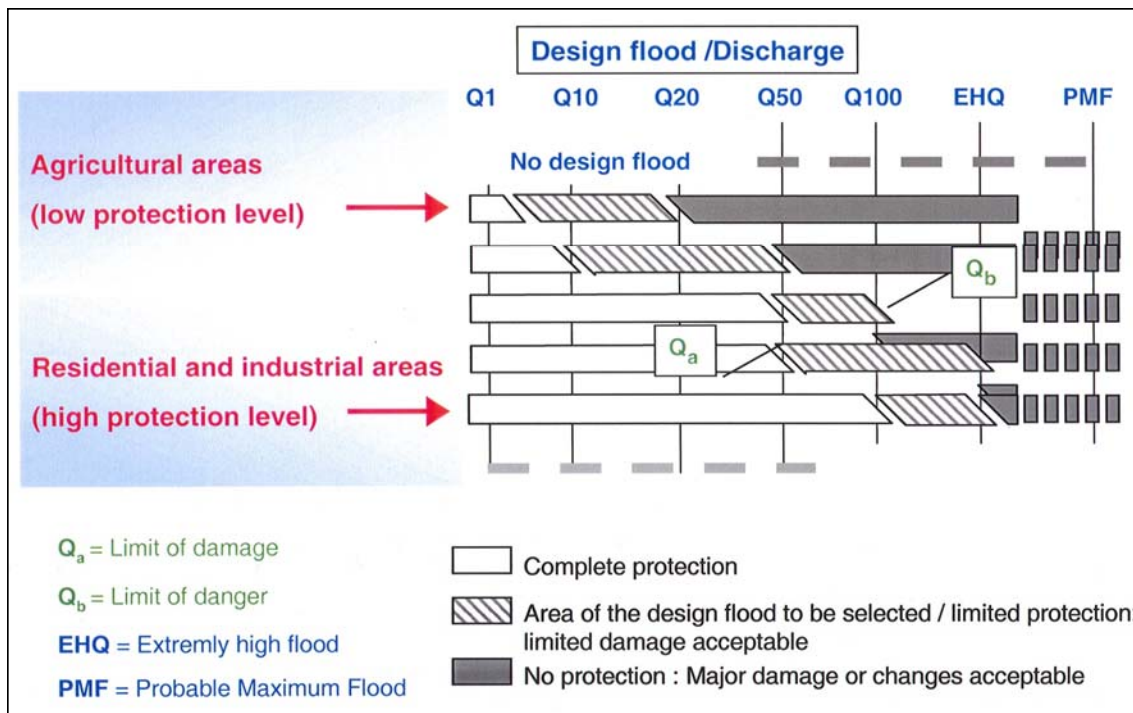
- Long-term appropriate monitoring of hydrological parameters (water level, flow velocity, discharge, sediment transport, u.a.s.o) is necessary. Depending on the type of the river different technologies must be used.
- The knowledge of the flood generation and concentration processes is very important.
- The analysis of historical floods can help to determine flood flow statistics.
- The impact of climate change on discharge has to be investigated.
- Monitoring is expensive in Switzerland, therefore an expert system for the determination of discharge in ungauged basins has been developed.
- Sediment plays a dominant role in mountain flash floods. The monitoring procedures used in Switzerland are presented. An expert system for the estimation of sediment potential and sediment transport in mountain catchments has been set-up.

### 3) Protection measures

Selected protection measures as biological technique, check dams, block ramps, specialized dam construction, opening of river bed, buhnes, debris flow breaker, moveable bridges, floating material retention, sediment retention, are shown and maintenance procedures proposed.

### 4) Presentation of examples

- Diversion of water and sediment to locations where it will cause least harm (Sachseln)
- Differential safety concept (Reuss-Uri)



Finally some selected guiding principles in flash flood management are presented.